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In War and Peace
THEY STAND TOGETHER

IT'S A "fur piece" from Chile's vast nitrate storehouse to the hungry farms of our homeland. Yet Chilean workers and American farmers have long been friendly neighbors.

It began more than 100 years ago with the landing of the first trial shipment of nitrate at Norfolk, Va., in 1831. Endless fleets of vessels have followed that little schooner, first around Cape Horn, later through the Panama Canal, carrying precious cargoes to feed countless crops of vegetables, corn, grain, fruit, cotton and tobacco.

History does not wholly reveal the tremendous sum of all these cargoes. Whether it be 10 or 50 million tons, the record leaves no doubt that, in the course of the century-long adventure, the Chilean nitrate industry has made a mighty contribution to the welfare and security of America and her fighting allies in the most devastating wars the world has ever known. For nitrate, which is unsurpassed in agricultural efficiency, is also a source of nitric acid, a vital factor in all explosives.

In the first World War large quantities were required for munitions. In this war, the great bulk of the Chilean nitrate supply has been devoted to its most natural use—production of food and feed—the crops most necessary to help win the war.

Despite difficulties of ocean transport in war time, Chile's shipments to Allied nations have averaged about 1¾ million tons yearly. This year, the United States alone has had almost one million tons—more than any year since 1930. Practically all of it has gone to our farms. Had it not been for this and for the whole-hearted cooperation of the U. S. Department of Agriculture, War Shipping Administration, War Production Board, Defense Supply Corporation and other federal and state agencies, admirably supported throughout by the entire fertilizer industry, the present food crisis might have become a disaster.

Almost half our fertilizer nitrogen each year goes for top dressing or side dressing. Practically all Chilean soda is top dressed or side dressed. To a million farmers "putting out soda" is a tradition, handed down from generation to generation. Farmers who regularly top dress grain, fruit and vegetables, know what would have happened this year without their regular supply of soda. They'd as soon quit farming.

Yes, in war and peace, in good years and bad, these good neighbors have stood together, shoulder to shoulder. And so they stand today with every resource devoted to the vital job of producing food for our armed forces, our allies, our war workers and our home folks.

CHILEAN NITRATE EDUCATIONAL BUREAU, INC.

120 Broadway • New York, N. Y.

BUY WAR BONDS AND STAMPS

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...THE...

AMERICAN FERTILIZER

"That man is a benefactor to his race who makes two blades of grass to grow where but one grew before."

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Quenched Calcium Silicate Slag

A By-Product Substitute for Limestone and Superphosphate*

By W. H. MacINTIRE and S. H. WINTERBERG

A SUBSTANTIAL increase in crop production is essential to the successful prosecution of the war, for home-front requirements, and to meet the urgent need of our allies for foodstuffs. To assure this increase and to safeguard our natural reserves, it is imperative that the potential supply of phosphates be conserved through more effective utilization. It has been concluded that these needs and an augmented purchasing power of farmers will bring a marked increase in the demand for phosphatic fertilizers and liming materials. This publication is intended as a contribution that will facilitate the meeting of that demand.

The beneficial effects of the rational use of superphosphate with limestone on acidic soils have been demonstrated repeatedly by experiment station results and by the experience of farmers. Now, however, farmers and the fertilizer industry are faced with the fact that war demands and present priorities have brought a severe strain upon the manpower, equipment, and facilities necessary for mining, manufacture, and movement of the materials utilized in the manufacture of phosphatic fertilizers and in the production of limestone. Even should these two commodities be produced in adequate quantities, deliveries to the farmers still will be hampered by the difficulties of transportation. This situation will become more and more acute. Therefore, it is essential that we explore every possible source of effective phosphate-lime materials that can be obtained with a minimum of haulage.

Until recently, relatively small amounts of phosphates in forms readily utilizable by plants were to be had through by-product materials at costs in line with those for the phosphate in commerical fertilizers. Now, however, large quantities of a cheap slag that contains phosphates are obtainable in the several states wherein elemental phosphorus is produced in rock phosphate-reduction electric furnaces. At first, the slag was advocated as an effective liming material. Now it is proposed as an emergency substitute for an economic addition of superphosphate along with one rational liming with ordinary limestone, as distinct from dolomite. The utilization of this by-product, hitherto disregarded as a carrier of effective phosphates, would lessen the strain on our output of commercial phosphates and thus contribute to our War Program. The proposed substitution of the dual-purpose by-product slag is deemed an especially feasible and economical means of providing a liming material to those Mississippi Valley areas that are distant from limestone deposits and to which the slag can be barged on waterways.

This bulletin is a report on cooperative laboratory and greenhouse experiments relative to the value of a new material, *quenched calcium silicate slag*. This material is a by-product from the Wilson Dam operations of TVA, and from similar operations by two industrial companies. It is derived only from rock phosphate-reduction furnaces in the production of elemental phosphorus.

The findings here published were obtained in chemical and pot-culture investigations conducted since 1934 at the University of

*Excerpts from Bulletin No. 184, published by the University of Tennessee Agricultural Experiment Station, Knoxville, Tenn.

Tennessee Agricultural Experiment Station, in collaboration with the Departments of Chemical Engineering and Agricultural Relations of the Tennessee Valley Authority. These findings are supplemented by observations and conclusions submitted by county agents as to results obtained by farmers in sections where substantial quantities of the slag have been used during the past four years.

Source and Nature of the New Quenched Calcium Silicate Slag that Carries Phosphate

The development of the electric furnace for the production of elemental phosphorus through the decomposition of rock phosphate is an outstanding achievement of the fertilizer program of TVA at Wilson Dam, Alabama. The production of the quenched slag is a complementary achievement of substantial value.

During the separation of the phosphorus from the other components of rock phosphate in the electric furnace, the calcium content of the rock is converted to a silicate. This calcium silicate constitutes the main body of the slag, which is drawn from the furnace at white heat. At first, the molten slag was allowed to cool in bulk to become a blue-gray, rock-like crystalline mass, the grinding of which was relatively expensive. Now, however, it is quenched by jets of water and shattered into whitish grainy particles that are pitted, porous, and brittle. The water-suspension of the quenched material is pumped to a distant pile. The quenching saves the expense of grinding and converts the slag into a more soluble and glassy, or non-crystalline, form. This form, which reacts more readily with the soil, is the one now sold as a liming material.

Although the electric furnace has been brought to a high degree of effectiveness, a small fraction of the furnace charge of raw rock phosphate remains undecomposed and occurs as a fused component of the slag. Hence, the use of the beneficial slag on soils practically completes the recovery of the phosphate charged into the furnace. The quantities of quenched slag now to be had, and the cooperative studies as to its effectiveness as a wartime replacement for an ordinary incorporation of limestone and an addition of superphosphate, would not have developed except for the accomplishments of the Authority at Wilson Dam and the program conducted cooperatively with the several agencies of the Land-Grant colleges. This fact demonstrates the fulfillment of a peacetime objective of the Authority and constitutes a contribution to wartime demands.

The recent increase in the output of quenched slag is a result of the imperative need of elemental phosphorus in the manufacture of munitions and combustibles, essential phosphatic chemicals, and nutritional phosphates. The Authority has been authorized to erect additional electric furnaces to provide more phosphorus for the expanding war program, and those furnaces will augment the supply of the new type of slag. Since war needs take precedence, the output of elemental phosphorus will be allocated chiefly to those needs, rather than to the manufacture of fertilizer phosphates. Hence, the peacetime output of concentrated phosphatic fertilizers at Wilson Dam will be diminished, and even may be terminated, until after the war. This diversion of the phosphorus produced by the electric furnaces will aggravate the problem of adequate supplies of phosphatic fertilizers.

The grainy *quenched calcium silicate slag* should not be confused with the well-known ground basic slag of the steel industry. Ground basic slag is officially defined, classified, and sold as a phosphatic fertilizer. It is used primarily to supply phosphorus rather than as a carrier of lime, and does not provide nutrient calcium to the extent that this element is supplied by a corresponding quantity of limestone. The limited and secondary liming value of the basic slag, and its cost, do not warrant its use at rates necewsary to the full correction of soil acidity. In contrast, the quenched calcium silicate slag has been recommended primarily as an effective liming material (17).* *Until now, its additional value as a carrier of phosphate has not been emphasized.* The quenched silicate slag contains practically all of the elements native to the raw rock phosphate and about one-twentieth of its phosphorus content (15). Hence, substantial phosphate additions are made to the soil when the slag is incorporated at rates equivalent to those recommended for limestone.

Composition and Properties of Quenched Calcium Silicate Slag

The partial chemical analyses, percentage neutralizing values, and mechanical make-up of nine silicate slags from industrial electric-furnace operations in Florida and Tennessee, and from the TVA furnaces at Wilson Dam, Alabama, are given in Table 1. The slag may contain a small percentage of potassium, but not enough to warrant its present considera-

*Figures in parentheses refer to literature cited at the end of the article.

tion as a fertilizing addition of that element. The iron, manganese, and other beneficial elements native to the raw rock phosphate are also fused into the slag. Spectrographic analyses of the slag derived from brown Tennessee rock phosphate at Wilson Dam were furnished by the Florida Experiment Station. Those analyses showed incidence of minute quanitites of the "trace," "minor," "secondary," or "less abundant" elements—zinc, strontium, vanadium, chromium, cobalt, zirconium, nickel, titanium, copper, molybdenum, beryllium, and boron.

In the remaining text, and in the illustrations, the term "slag" will be used to designate the quenched by-product derived from the electrically heated rock phosphate-reduction furnaces operated by the Tennessee Valley Authority at Wilson Dam. All of the slags used in the greenhouse experiments were from that source.

When the slag is drilled into the soil or broadcast and then either left on the surface or disced, its calcium silicate content undergoes rapid conversion to calcium carbonate, and thus the slag functions as does limestone. Along with this converstion goes a dispersal of the phosphate content in an extremely finely divided state. One ton of pure calcic limestone and 1.16 tons of pure calcium silicate are equal in liming value. The slag, however, although chiefly calcium silicate, is diluted with the compounds not volatilized from the three materials—rock phosphate, river gravel, and coke—that are charged jointly into the electric furnaces. Hence, a rate of 2½ tons of the unground slag per acre is prescribed to effect soil "sweetening" equal to that induced by two tons of high-grade calcic limestone. When such an incorporation of the slag undergoes disintegration in soil, the input of effective phosphate will correspond to the addition of from 375 to 500 pounds or more of 16 per cent superphosphate.

The initial chemical studies (15) indicated that the phosphate content of the slag is largely in forms utilized readily by plants. This indication was substantiated by findings obtained through an extensive series of greenhouse pot cultures, some of which are pictured in this bulletin. When the incorporated slag undergoes chemical dissolution, its silica content is liberated in a jelly-like hydrous form. Apparently this generated hydrous form of silica has some beneficial action in relation to the effectiveness of the phosphate content of the slag.

Minute quantities of boron are required by plants. It has been concluded that the incorporation of limestone may decrease the solubility of the meager quantities of native boron in the soil to an extent detrimental to plant growth. No indication of boron deficiency was observed in any of the crops grown on the slagged soils of the pot cultures now reported. The spectrographic examinations indicated that a 2½-ton addition of slag supplies from four to five pounds of boron, whereas chemical analyses indicated only a fraction of one pound (22).

In a recently reported pot-culture experiment (20), incorporations of the silicate slag likewise failed to induce indication of boron deficiency. In those experiments, the injurious effect induced by the limestone alone was prevented by small additions of borax. In

TABLE I

Mechanical and chemical percentage analyses and neutralizing values of quenched calcium silicate slags, produced at different places in three states.

Slag No.	Year produced	Mechanical analysis: Fractions passing mesh designated 4	10	16	20	60	Chemical analysis [1]: Lime (CaO)	Silica (SiO_2)	Phos. acid (P_2O_5)	Fluorine F	Neutralizing value in terms of limestone ($CaCO_3$-equivalent)[1]: Computed[5]	Titrated
S-349[2]	1935	100	84.6	56.2	35.4	3.9	54.3	35.8	1.38	3.17	87.5	84.0
S-653[3]	1938	100	92.0	66.1	42.8	2.5	45.1	42.3	1.40	2.20	71.7	70.0
S-657[3]	1939	100	70.0	45.4	27.4	3.8	42.6	41.7	1.25	2.47	66.9	68.0
S-686[2]	1938	100	64.0	34.8	19.7	1.8	49.8	40.0	1.84	2.37	78.9	79.0
S-693[2]	1939	100	92.7	75.6	57.1	8.7	52.1	39.9	1.30	2.30	84.2	80.0
S-792[4]	1940	100	81.1	47.9	28.4	4.4	50.8	40.9	1.75	2.16	81.8	79.5
S-795[2]	1940	100	98.7	88.2	73.7	16.4	52.7	34.9	1.25	3.20	84.0	79.0
S-1053[2]	1942	100	99.0	97.0	90.0	22.0	50.8	36.7	0.93	2.25	82.7	77.0
S-1058[2]	1943	100	98.0	88.5	69.0	8.0	52.2	36.9	2.30	2.31	82.3	66.7

[1]Determined by use of a quartered sample ground to pass a 100-mesh sieve.
[2]Wilson Dam product.
[3]Commercial Tennessee product.
[4]Commercial Florida product.
[5]Equivalence of total calcium minus that accounted for by phosphate and fluoride content.

contrast, similar additions of borax did not increase the beneficial effect of the slag upon plant growth.

Previous Observations as to the Liming Value of Calcium Silicates

Since most of the soils of the humid region are acidic, their calcium content occurs chiefly in various silicate combinations, from which plants mainly derive their nutrient calcium. Laboratory and pot-culture experiments as to the neutralizing effectiveness and the nutrient value of calcium added as the mineral silicate, wollastonite, were first reported from the Tennessee Experiment Station in 1914 (2). As early as 1864, however, and long before the advent of ground limestone, an English geologist stated that liming with the silicate form of calcium—presumably an iron-furnace slag and therefore carrying phosphate—would not induce the harmful effect then known to follow heavy applications of the caustic forms of lime (1). The liming value of calcium silicate of various types was shown by subsequent investigations at the Ohio (3, 9), Rhode Island (7), Kentucky (8),New Jersey (10, 11, 12), Pennsylvania (13), Indiana (16), and Alabama (20) Experiment Stations, and by the personal researches of Cowles (5, 6). Moreover, for some 18 years, the Virginia and Tennessee Experiment Stations have studied the conservation of calcium through incorporations of by-product calcium silicate, in comparison with chemically equivalent quantities of burnt lime, limestone, and dolomite (14).

The fact that the results of an experiment to settle an academic question may be translated into unanticipated practice is demonstrated by the present outcome from the initial silicate study reported from the Tennessee Station in 1914 (2). In experiments to ascertain whether the response to the calcium content of incorporated limestone is the same before and after the limestone is decomposed in acidic soil, the carbonate and a mineral silicate of calcium were compared in the laboratory and in pot cultures. The laboratory comparisons indicated a like degree of solubility for the two materials, and red clover responded better to the silicate combination in pot cultures.

When the operations of the rock phosphate-reduction furnaces at Wilson Dam brought a substantial output of a new type of calcium silicate slag, it was logical for the Tennessee Station to undertake a study of the liming possibilities of this by-product. At that time the molten slag was disposed of by delivery from the furnaces into cars and allowed to cool in bulk. The resultant was a crystalline material. In the initial chemical study (15) a ground sample of this air-cooled slag was compared with some of a 100-pound lot of the same slag, S-349 of Table 1, that was quenched experimentally by delivery into water. The quenching produced a non-crystalline grainy material of glassy nature. Samples of 100-mesh grindings of both quenched and unquenched slag later were sent to the late S. D. Conner, of the Indiana Experiment Station, for laboratory and pot-culture studies. His findings as to the neutralizing value of the slag and as to the greater reactivity of the quenched material were transmitted by letter and later were published (16). His conclusions were in accord with those from the studies that had been conducted at the Tennessee Station under the auspices of the Tennessee Valley Authority.

All of the slag drawn from the TVA rock phosphate-reduction furnaces at Wilson Dam is now quenched by an ingenious method and a novel device developed by the Chemical Engineering staff of the Authority and depicted on the cover page. The improvement in the quenching operation is evidenced by the fact that the percentate of particles finer than 20-mesh, as a mean for the slags of 1940, 1942, and 1943, is more than twice the percentage in the slag quenched by the requested small-scale experimental immersion. The corresponding ratio for minus 60-mesh siftings is 1 to 4.

The Fluorine Content of the Slag

The low solubility of raw rock phosphate is attributed to its fluorine content, which is in chemical combination with its phosphate content. The disruption of that combination is effectuated and variant proportions of fluorine are removed in the manufacture of the several types of phosphate fertilizers.

Most of the fluorine carried by the furnace charge of raw rock phosphate is retained in the slag. Chemical and pot-culture studies therefore were inaugurated to determine the effect of the fluorine content of the slag upon phosphate solubility when the slag is mixed with superphosphate outside and within the soil. It was found that the slag should not be used as a substitute for limestone or dolomite in mixtures with superphosphate outside the soil, particularly if the slag-superphosphate mixture is wetted and allowed to age before incorporation (15). There was no indication, however, that the fluorides introduced into the soil through the incorporation of slag caused any decrease in the plant response

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Industry Advisory Committee Meets

THE Fertilizer Industry Advisory Committee met in Washington on May 12th, David Meeker, U.S.D.A., presiding. Present also: M. Lee Marshall, Deputy Administrator, War Food Administration, D. W. Aitken, A. G. Howard, W. E. Lafkin, F. W. Parker, L. G. Porter, J. H. Stallings, W. F. Watkins, U.S.D.A.; S. L. Clement, Dale C. Kieffer, H. H. Meyers, Edmund Rowland, WPB; J. C. Freeman, Cedric G. Gran, Henry A. Huschke, Roland Payne, Paul L. Poirot, OPA; H. B. Baylor (for Franklin Farley), George Cushman, M. K. Derrick, J. C. Devilbiss (for H. M. Albright), R. B. Douglass (for O. F. Smith), N. E. Harman, S. B. Haskell, M. H. Lockwood, M. H. McCord (for C. F. Hockley), J. A. Miller, John L. Morris (for Wm. B. Tilghman), Weller Noble, O. J. Noer, John E. Sanford, C. D. Shallenberger, H. V. B. Smith, F. J. Woods, J. A. Woods, members of the Committee; Charles J. Brand, D. S. Murph, N.F.A.

M. Lee Marshall, recently appointed Deputy Administrator, W.F.A., was introtroduced and spoke briefly. He expects to promote close cooperation of WFA with WPB and other Government agencies in connection with fertilizer problems of the food production program.

Several members of the Committee made the point that pertinent information as to prospective action by Government agencies should be given to the Committee in advance so as to enable it to perform its advisory functions more effectively. Government officials stated that the Committee has made important contributions to the war program; that, as the Committee meets only once a month and as problems arise and situations change from day to day, it is not always possible for them to consult the Committee before taking action; that final responsibility for action rests on the Government; that there had been no intentional withholding of information from the Committee; that failure to give sufficient information was due to oversight and understaffing; and that they would provide more information to the Committee in the future.

Subcommittee on Organic Nitrogen

The subcommittee on organic nitrogen made a report. The subcommittee felt that an improved outlook for probable supplies of chemical nitrogen lessens the need for a program to control organic nitrogen; and, after weighing the difficulties and possible advantages of control, recommended that no control be set up, expressing the belief that no substantial effect on agricultural production would result. The report pointed out that organics (estimated supply approximately 21,000 tons N.) would probably constitute less than 5 per cent of the total nitrogen supply available for next year's use. The subcommittee believes that producers of organics, acting separately and independently, will distribute their material as equitably as it is possible for them to do.

However, if Government officials conclude that control should be exercised, the subcommittee recommended, in preference to other plans, that, east of the Rocky Mountains, natural organics be placed under outright allocation, the short supply to be proportionately distributed in all geographical areas heretofore using them, and to each individual company by plants on a percentage basis in direct ratio to the estimated available supply. The 1941–42 season should be the basis for making allocations, which should be based upon the total amount of organic materials used by each plant in mixed fertilizers. The plan contemplates separate allocations for two six-months periods.

The report recommended that before allocations are made to fertilizer manufacturers, agreement be reached with the War and Navy Departments as to the amount of natural organics to be used for airfield fertilization or similar purposes, and that the agreed amount be set aside for such purposes. Further recommendations: That oilseed meals, which may not now be used in making mixed fertilizers, should not be used as meals for fertilizer purposes, since such use diverts them from feeds; that other natural organic materials should not be used as such but should be used in mixed fertilizers so as to employ them in the most efficient manner.

It was suggested that allocation of organics, as well as chemical nitrogen, on an historical basis might not contribute in all cases to production of "A" crops. Some companies sell fertilizers for both "A" crops and "B" crops, while others, notably on the Pacific Coast, sell for "B" crops only, such as

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Principal Articles in This Issue

A "Strictly Business" Convention

A has been emphasized in the bulletins and literature of the National Fertilizer Association, the Annual Convention to be held at Hot Springs, Va., on June 21st to 23rd, will be devoted solely to the business of the Association and its relation to the war effort. The usual general invitation to attend this gathering has been omitted and it is expected that the attendance will be composed chiefly of active and associate members and contributors, and of government officials. No social social events have been scheduled, the golf tournaments are out for the duration, even the annual convention dinner is among the missing.

For the two open sessions on June 22nd and 23rd, a series of timely addresses has been scheduled. President John A. Miller will review the wartime work of the association, while the remaining talks will be by officials of the W. P. B., the Food Administration, OPA, and the U. S. Department of Agriculture. These include:

"Nitrogen Supplies and Their Allocation," Edmund Rowland, Acting Chief, Nitrogen Unit, War Production Board, Washington, D. C.

"Potash and Superphosphate Supplies and Problems," Dale C. Kieffer, Chief, Fertilizer Materials Unit, War Production Board, Washington, D. C.

"The 1943–1944 Fertilizer Distribution Program," Wm. F. Watkins, Chief, Requirements Section, Fertilizer Division, War Food Administration, Washington, D. C.

"Fertilizer Pricing Problems," Cedric G. Gran, Head, Agricultural Chemicals Unit, Office of Price Administration, Washington, D. C.

"Manufacturing Problems Involved in Using Ammonium Nitrate," Dr. F. W. Parker, Chief, Division of Soil and Fertilizer Investigations, U. S. Department of Agriculture, Washington, D. C.

The discussion of the current situation by the members present will be led by M. H. Lockwood, of Eastern States Farmers Exchange, and by Dr. Arthur M. Smith, of Synthetic Nitrogen Products Corporation.

The election of members of the Board of Directors whose terms expire in 1943, will be held and at the close of the Wednesday session, the new Board will elect officers for the coming year.

Meyers Elected V-C Vice-President

H. H. Meyers, who recently resigned as chief of the Nitrogen Unit, WPB, after serving for 20 months and who still serves as a consultant to the Chemical Division, has been elected a vice-president of Virginia-Carolina Chemical Corp. on May 18. Mr. Meyers has served the corporation as manager of the Purchasing Department since 1936. Prior to that he was engaged for many years in research on fertilizer and heavy chemical problems, first with the American Smelting & Refining Co.; later for a period of years he occupied the Armour Research Fellowship at the Mellon Institute of Industrial Research, and then was associated with The Barrett Co.

Pennsylvania Fertilizer Consumption Increasing

A grade survey for Pennsylvania, for the calendar year 1942, has just been completed by Dr. Charles F. Noll, head of the Department of Agronomy of Pennsylvania State College, in cooperation with the Association. It indicates a total consumption of all fertilizers of 365,503 tons, as compared with 302,690 tons for the calendar year 1941. The ten leading grades included over 80 per cent of the mixed fertilizer tonnage. These grades, arranged according to rank, are: 3–12–6, 46,469 tons; 0–14–7, 41,844 tons; 2–12–6, 38,076 tons; 4–8–8, 30,275 tons; 0–12–12, 22,355 tons; 2–9–5, 17,489 tons; 4–16–4, 7,936 tons; 2–8–10, 7,927 tons; 5–10–5, 7,713 tons; and 5–10–10, 6,991 tons. Spring sales totaled 237,118 tons; fall sales, 91,500 tons; undivided as to spring or fall, 36,885 tons. Sales of superphosphate totaled 75,647 tons; all other materials, 7,919 tons.

Fertilizer Allocated for Food, Feed Crops

The War Food Administration has announced that a considerable quantity of ammonium nitrate is being allocated to specific areas of the Nation in a move to help farmers increase their production of food and feed crops. Allocation of the fertilizer material was made possible through adjustments in its use for other war purposes.

Approximately 24,000 tons of the ammonium nitrate are being allocated for immediate use on food and feed crops in Louisiana, Arkansas, Mississippi, Georgia, Alabama, and for use on pasture and forage crops in the New England states. It is expected that some may also be made available in North and South Carolina.

WFA officials said that ammonium nitrate is a fertilizer product new to farmers in those areas. It contains from 32 to 34 per cent nitrogen, about twice the nitrogen content of nitrate of soda, which is normally used in the areas to which the ammonium nitrate is being allocated. It will be used primarily for direct application to food and feed crops as a measure to boost production of such crops this year.

Because of the high nitrogen content, it was pointed out that farmers should follow the recommendations of state agricultural authorities as to rate of application and method of handling to obtain best results.

The ammonium nitrate will be available from regular fertilizer suppliers in the areas concerned.

New Sources of Salvage Fats and Oils Sought For

The nation's 40,000 chemists are being asked to help find new sources of waste fats and vegetable oils for salvage purposes it was announced this week by Marcus W. Hinson, senior industrial specialist of the Chicago War Production Board's salvage division.

Hinson, who was loaned to WPB by the American Chemical Society to set up a national program for industrial fats and oils recovery, says that industrial needs for 1943 alone call for at least 350,000,000 pounds of fats and oil.

Hinson has set a national goal of 500,000,000 pounds but declares this will be reached only if the nation's chemists are able to discover new methods and sources of fats and oils salvage.

Chief industrial sources now being used, include meat packers and processors, makers of salad dressings and margarine, canners of chicken, cotton seed and soy bean processors, and soap manufacturers. Salvage from these sources probably could be increased by improved recovery methods but one of the biggest problems is tapping new sources from other industries, Hinson said.

Hinson asks that new ideas be transmitted to him at Room 909, National War Agencies Building, 226 West Jackson Blvd., Chicago, Illinois.

Bemis Bro. Bag Co. Plant at St. Louis Wins Safety Award

Industrial accidents in wartime are especially serious because they sap the productive power of our nation when it is needed most. In the first year of the present war, 8,192 U. S. fighting men were lost on the battle fronts of the world, but in the year 1942, 46,500 American workers were killed in accidents.

Most manufacturers experienced increases in their accident rate in 1942 because:

1. Of the increased number of hours plants were operated.
2. Many new workers were employed who were unfamiliar with the hazards of factory work.

The St. Louis Safety Council reports that 524,000 man-hours were lost in the City of St. Louis in 1942 as a result of industrial accidents.

The Bemis Bro. Bag Co., St. Louis, made the remarkable record of operating 1,192,912 man-hours in 1942 without a single lost-time accident. For this extraordinary achievement, the St. Louis Safety Council recently presented the Bemis Company with a handsome bronze plaque. N. S. Smith, superintendent, is an accident-prevention enthusiast and under his method of supervision the Bemis plant accomplished this unusual safety record. No less than six safety awards have been won by Bemis in past years in competition with other St. Louis industries.

Accident prevention is important at all times, but now more especially so because the supply of essential war materials must roll down production lines continuously. Machines may be replaced, but skilled men require long periods of training to be of real value. Accident prevention work is a genuine contribution to victory.

Boll Weevil Outlook for 1943

The rate of boll weevil survival this season in the eleven States from Virginia to Texas indicates that serious damage to cotton is likely if the weather in June and July is cloudy and wet in the cotton growing areas, the U. S. Department of Agriculture said on May 19th.

Hot, dry weather in June and July would do much to relieve the threat, by killing the first generation grubs. The Department, however, urges growers who have suffered losses recently from boll weevils to be prepared to fight them this year. Control methods are described in circular E-569, Control of Cotton Insects, available on request to the United States Department of Agriculture, Washington, D. C.

Survival counts and estimates of weevil infestation were made this year by the Bureau of Entomology and Plant Quarantine, Agricultural Research Administration, in several places in the Cotton Belt. In Florence County, in northeastern South Carolina, boll weevils were found under leaves and trash in woods adjacent to old cotton fields, at the rate of 2,995 per acre. There were more boll weevils in that region this year than during March and April of any recent year except 1939. The weevils were about one-third more abundant than they were in the early spring of 1942 and 1941, and about 17 times as abundant as in the spring of 1940, a year of unusual scarcity of boll weevils in South Carolina.

In Tift County in southern Georgia somewhat smaller numbers of boll weevils have survived the winter. Examinations in this area indicated only 97 weevils per acre. In Washington and Bolivar Counties in the Delta section of western Mississippi, near the Mississippi River, very few weevils survived.

FERTILIZER MATERIALS MARKET

NEW YORK

Sulphate of Ammonia Still in Big Demand. Potash Price Schedules Unchanged, Subject to Later Changes by OPA. Imports of Russian Potash Expected to Offset Lend-Lease Potash Exports. Superphosphate Market Becoming Tighter.

Exclusive Correspondence to "The American Fertilizer"

NEW YORK, May 18, 1943.

Sulphate of Ammonia

There has been no change in the price of this material and no slacking in the demands whatsoever. Buyers are continuing to press for delivery on orders which were placed after definite allocations had been made.

Nitrate of Soda

There is no change in price and material is being delivered regularly against definite allocations.

Superphosphate

Demand continues and with the possible diversion of considerable quantities of this material for purposes other than fertilizer use, we can expect this market to become tighter.

Potash

There has been no change in the price schedule on muriate of potash and contracts will be issued on the basis of the plublished price schedules which are the same as for the previous year. However, O.P.A. definitely reserves the privilege of revising prices up or down but is not likely to make any change without calling a meeting of all manufacturers.

The buyers in most cases, are attempting to have reservee for them their expected requirements, which in most cases are more than manufacturers will be able to allot to them, but no sales can be definitely confirmed until definite allocations have been made to the buyers by W.P. B.

It is expected that considerable quantities of potash will be imported from Russia, but against this it is expected that we will furnish a large quantity to Lend-Lease, which latter quantity will probably be larger than maximum expected from Russia. It is indicated that domestic fertilizer manufacturers will be alloted about 10 per cent less potash than their average of the past two seasons.

BALTIMORE

Fertilizer Shipments Hampered by Shortage of Labor. Late Spring Weather Shortens Fertilizer Season. No Change in Material Situation

Exclusive Correspondence to "The American Fertilizer"

BALTIMORE, May 18, 1943.

The fertilizer shipping season is now at its height, and manufacturers are still hampered in getting out their tonnage, due to scarcity of labor. Up until the present time the weather has been exceptionally cool for this season of the year, which has been helpful, but the change to much warmer weather will have a tendency to shorten the fertilizer season. From all indications it would appear the tonnage will compare favorably with last spring.

Ammoniates.—Organic ammoniates for fertilizer are practically unobtainable, as the entire production is being used for feeding purposes.

Nitrogenous Material.—The market is bare of stocks. Vegetable meals are also in short supply, with all manufacturers completely sold up.

Sulphate of Ammonia.—There is no change in the situation, and it is anticipated that the tonnage will continue to be allocated for, at least, the duration of the war.

Nitrate of Soda.—The present is the heaviest consuming period of the year for this article, and allocations have recently been fairly liberal.

'AERO' CYANAMID—ALWAYS IN SEASON

'AERO' CYANAMID, which formerly was used only in the spring and fall, is now needed by fertilizer manufacturers and farmers twelve months in the year.

In the fertilizer plant, Cyanamid was considered as a fall and winter material for basing. Now it goes into late-spring mixtures, early-fall mixtures, as well as into the usual winter operations. It is practical for basing, curing, and also for building to grade.

On the farm, in addition to application as a spring and fall fertilizer, Cyanamid is used to control weeds in oats; as a weed repellent for asparagus; and throughout the year, for plowing under with green-manure crops or crop residues to build up a rich humus supply in the soil.

The demand for Cyanamid is growing because of its many uses; and because it contains both nitrogen and lime — a combination to which most soils respond very favorably.

AMERICAN CYANAMID COMPANY
FERTILIZER DIVISION
30 ROCKEFELLER PLAZA, NEW YORK, N. Y.

Potash.—There is no change in the situation except that it is not permissible to sell potash in excess of one ton per month from one manufacturer to another.

Superphosphate.—The demand continues good and, due to the restrictions surrounding both liquid and mineral ammonia, it would appear that this has been offset by increased percentages of available phosphoric acid and potash in mixtures. Ceiling price of 64 cents per unit of A.P.A., in bulk, still prevails.

Bone Meal.—The market is practically bare of offerings, and the demand is also dormant.

Bags.—There is no change in the burlap situation as far as fertilizer bags are concerned, but these have not been much of a factor this season due to the lower pro rata cost of paper bags which have been more extensively used this year than ever before.

PHILADELPHIA

WFA Order for Use of Organics in Fertilizers Announced. Season Advanced but Demand for Materials Continues.

Exclusive Correspondence to "The American Fertilizer"

PHILADELPHIA, May 17, 1943.

The War Food Administration order covering the use of organic nitrogen materials was the biggest piece of news during the last week or so. The trade, however, is still somewhat in doubt as to just how the mechanics of the order are supposed to be handled, but that will probably be ironed out soon. Otherwise, announcement of price schedules by potash producers and a urea manufacturer held the spotlight.

Ammoniates.—Even though the season is now somewhat advanced, the demand for ammoniates still continues. As mentioned before, little or no higher testing ammoniates turn up, and the supply of the lower analysis materials is none too plentiful.

Sulphate of Ammonia.—Demand still keen, and production is being taken up as offered.

Nitrate of Soda.—Some small quantities of imported material have arrived, and supplies are still being allocated.

Superphosphate.—It is reported that production of this material has been increased somewhat, but the demand still holds.

Bone Meal.—Demand exceeds the supply. Any lots that might show up infrequently are snapped up immediately.

Potash.—While production is apparently holding at a high rate, yet the demands absorb it easily. The vegetable potash-bearing materials have aroused some interest.

CHARLESTON

Potash Price Schedules Issued but Demand Still Exceeds Suppy. Few Organic Materials Available for Fertilizer Market.

Exclusive Correspondence to "The American Fertilizer"

CHARLESTON, May 18, 1943.

Other producers of potash have issued their price schedules but it is not yet clear that all the manufacturers will be able to get their wants.

Nitrogenous.—The War Food Administration has issued an order regulating the distribution of organic materials, but no news has come out as to how this plan is to work.

Castor Meal.—Very large arrivals of castor beans have recently come into Northern ports, but Government purchases of castor pomace have taken practically all of it.

Dried Blood.—In this material, the same price prevails: $5.38 per unit of ammonia ($6.54 per unit N), f.o.b. Chicago. This makes it available only for feed.

Cottonseed Meal.—The price of the 8 per cent grade at Atlanta is $38.60, nominal. Soya bean meal is quoted at $45.75 at Atlanta but the supply is short.

CHICAGO

Fertilizer Organics Market Inactive with Few Offerings. Imports of South American Feeding Tankage Expected if Shipping Space is Available.

Exclusive Correspondent to "The American Fertilizer"

CHICAGO, May 17, 1943.

Relatively inactive markets continue in this territory. Prices hold unchanged at ceilings, but paucity of offerings is still with us. Just how the allocation of organics will function is not overly clear at this time, but it is hoped it will be for the best for all concerned.

The reports of shipments of South American tankage to this country for feed purposes are probably premature, as latest advices indicate that no bottoms are as yet available. The necessity, however, of such imports are most essential.

Ceiling prices on all fertilizer and feed materials are unchanged.

No change in ceiling prices: High grade ground fertilizer tankage, $3.85 to $4.00 ($4.68 to $4.86 per unit N) and 10 cents; standard grades crushed feeding tankage, $5.53 per unit ammonia ($6.72 per unit N;) blood, $5.38 ($6.54 per unit N); dry rendered tankage, $1.21 per unit of protein, Chicago basis.

TENNESSEE PHOSPHATE

Mining Operations Increasing with Added Prospecting for New Deposits. Phosphate Representatives Given Consideration by OPA.

Exclusive Correspondent to "The American Fertilizer"

COLUMBIA, TENN., May 17, 1943.

A preponderance of good weather interspersed with many highly desirable spring showers and occasional heavy downpours, has enabled both farmers and outdoor phosphate workers to get on with the major tasks on the farms and in the mines to good advantage in the past two weeks. Much of the corn has been planted, tobacco is set out, victory gardens are in fine shape and many first cuttings of alfalfa are already down. Mining of raw material phosphate has picked up and a great deal of prospecting both of reserves and for purchase of new deposits has been done. Several large transactions in the latter line are just on the eve of being closed and several of the higher officers from the main offices of the large companies have been in this section recently to give the final "once-over."

Movement of the unground material to plants of fertilizer manufacturers and electric furnace operators proceeds steadily as a routine matter of contract and shipment. All are covered by ceiling prices giving good returns for the large scale wholesale operations, covered by monthly composite analyses, going to unloading points equipped to handle quickly and economically, regardless of weather conditions or other work in which the consignees may be engaged.

Quite different is the problem of getting out the enormously increased shipments of ground rock for direct use by farmers, in which each car has to be analyzed separately, allowances made for deficiencies in phosphoric acid content and grinding, with no allowance for the cars which run above guarantee. They go to consignees who usually have only the one car to unload, and must get it when weather suits and other work on the farm is out of the way, or just right to apply the phosphate. Only active traveling and telephoning and correspondence on the part of local and general representatives of all the phosphate distributors in this consuming channel, are able to insure the equable allotment of this material. Little wonder, therefore, that rationing boards, wherever common sense consideration is given these facts, are removing these phosphate repre-

sentatives from the category of salesmen and furnishing them everything necessary in the way of tires, gasoline and new cars, telephone equipment and all such necessities on the basis of essential workers in the great effort to win the war.

Ground rock shipments, definitely known to have been at 70 per cent higher up to May 1, 1943, than for same period in 1942, continue at the same or even larger rate as far as can be told without figures.

Movement is reported on foot to have the rate of benefit payment for this material in the AAA program, made the same in all states. There is no allowance at all in two-thirds of the states and benefits range from $4.20 to $15.00 per ton in the others. It is hard to see what the AAA accomplishes by withholding from some farmers what is given others.

Rowland Heads Nitrogen Unit

Edmund Rowland has been named acting chief of the Nitrogen Unit of the Chemicals Division of the War Production Board, succeeding H. H. Meyers, who has resigned to return to the Virginia Carolina Chemical Company. Mr. Meyers was chief of the unit for twenty months, and will continue as a consultant.

INDUSTRY COMMITTEE MEETS

(Continued from page 8)

citrus crops. Companies of the former class, because of the necessity for giving preference to "A" crops, might be able to supply only a small percentage of fertilizers requested for "B" crops, while companies of the latter class might be able to supply all the needs of their "B" crop customers.

It was recognized that control of organics might involve difficulties disproportionate to the problems involved, but WFA officials stated that because of scarcity some control might be necessary. The objectives would be, first, to contribute to production of food crops, and, second, to distribute the supply equitably among manufacturers. The situation can be handled in one of three ways: (1) without allocation but with requests to producers: (2) through allocation: (3) through limitations as to crop use It was the consensus of the Committee that organic nitrogen materials should not be allocated.

Chemical Nitrogen

Government officials reported that the outlook for supplies of chemical nitrogen for next year has changed considerably within the past 30 days, through simultaneous decrease in estimated requirements for military use and the coming into production of new plants. The present outlook—which, of course, is subject to change—is that the supply of chemical nitrogen for fertilizer from North American sources may be around 511,000 tons N (as against an estimated consumption of about 430,000 tons this year). U.S.D.A. officials pointed out that this quantity would meet only the minimum requirements.

According to present outlook, roughly about half of the chemical nitrogen for mixed fertilizers will be in the form of solutions and ammonium nitrate (which has certain undesirable physical properties) and about half in the form of ammonium sulphate.

WPB plans a program to assure steady movement and utilization of the solutions and ammonium nitrate so as to conserve these sources of nitrogen. Equipment for storage of anhydrous ammonia as such does not exist either at producing points or at receiving points nor can such heavy duty equipment be obtained under present conditions. Ammonium nitrate also does not lend itself to storage because of its tendency to harden and the hazards incident to the character of the material.

In general, it is presently contemplated that solutions will be offered to fertilizer manufacturers, and, in case it should become necessary at any time to reduce chemical nitrogen allocations, the cut would not be retroactive. The manufacturer who had already used solutions in making mixed fertilizers would thus be assured, to that extent, of his supply of chemical nitrogen. It was suggested that manufacturers not equipped to use solutions should, as far as possible, make arrangements with their superphosphate suppliers or others to ammoniate superphosphate for them. Another suggestion was that ammonium nitrate might be substituted for solutions, at least to some extent, in cases

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FACTORIES

Alexandria, Va.
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Buffalo, N. Y.
Carteret, N. J.
Cayce, S. C.
Chambly Canton, Quebec, Can.
Charleston, S. C.
Cincinnati, Ohio
Cleveland, Ohio
Detroit, Mich.
East St. Louis, Ill.
Greensboro, N. C.
Havana, Cuba
Henderson, N. C.
Montgomery, Ala.
Norfolk, Va.
No. Weymouth, Mass.
Pensacola, Fla.
Pierce, Fla.
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Pierce, Fla.
Port Hope, Ont., Can.
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Savannah, Ga.
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Wilmington, N. C.

where manufacturers are not equipped to use solutions.

The supply of ammonium nitrate for fertilizer use next year is presently estimated at from 350,000 to 400,000 tons. Officials thought that about 120,000 tons might be used in mixed fertilizers and the rest for top dressing. It was suggested that a severe grade substitution plan might be the only alternative to the use of ammonium nitrate in making mixed fertilizers.

Some recommendations which had been tentatively considered, but which for lack of time for full consideration had not been acted on, were presented by the subcommittee on inorganic nitrogen:

1. That cement-hard ammonium nitrate be considered as not subject to allocation by WPB either for use in mixing, or for direct use as a nitrogen material. (Note: Uncertainty as to fire and explosion hazards incident to conditioning solid ammonium nitrate for use was commented on.)

2. That the Division of Fertilizer Investigations, Bureau of Plant Industry, U.S.D.A, be asked to prepare specifications as to treatments of ammonium nitrate which will result (a) in the product being acceptable for limited use in mixing; and (b) for use in top- and side-dressing; and that allocations of ammonium nitrate be confined to material treated as per these specifications.

3. That as far as production of ammonium nitrate in Government-controlled plants is concerned, use in solution form be considered as most economical, and most acceptable to fertilizer manufacturers; and that such use take precedence over conditioned solid ammonium nitrate for direct use as a nitrogen material.

4. That in view of the probable limited storage properties of any ammonium nitrate conditioned for use as a material, FPA be requested to organize campaigns for fall application of ammonium nitrate as material, in those areas where fall application gives crop results substantially equal to spring application. (Note: The report pointed out that in the Mississippi Delta fall applications have been found substantially equal to spring applications, and in the Northeast nitrogen used on grasslands in late summer and fall is substantially equal to spring application.)

5. That if, because of the amount of ammonium nitrate which may be allocated for use in mixtures, and in view of the necessity of spreading the shipping period of mixed fertilizers over many months, it becomes necessary for fertilizer manufacturers to pack in lined, moisture-resistant sacks, the OPA recognize the added cost incident to such packing, in any price ceiling which may be set.

It was stated that the Division of Soil and Fertilizer Investigations, Bureau of Plant Industry, Soils, and Agricultural Engineering, U.S.D.A., is engaged in the preparation of an article on formulation of fertilizers for the 1943–44 season, with particular attention to the use of ammonia solutions and ammonium nitrate.

It was reported that no decision has yet been reached on the recommendations made by the Nitrogen Unit of WPB for continued importation of Chilean nitrate of soda. The opinion was expressed that considerably more nitrogen than the estimated 511,000 tons of North American production can be absorbed by agriculture. The Committee adopted a resolution favoring the largest possible importation of Chilean nitrate of soda next year, and in no event less than the total brought in this year if shipping space is available.

Superphosphate

The subcommittee on superphosphate reported that, subject to adequate transportation and labor, the available raw materials and production facilities indicate a supply of between 6,000,000 and 7,000,000 tons of normal superphosphate for fertilizers in 1943–44. The demand during 1943–44 will justify every effort to increase the production as indicated. To bring about this increased production it is essential that regular movement of normal superphosphate from the plants be maintained throughout the entire year, by the moving of an average of not less than 500,000 tons each month. (March, 1943, production was 611,000 tons.) This will involve adjustment of deliveries to mixers and to AAA, and earlier deliveries of mixed fertilizers to farmers. Movement of superphos-

phate during the summer months should be stimulated by the release of nitrogen solutions to fertilizer manufacturers- The volume of concentrated superphosphate available for domestic use will depend on amounts released for Lend-Lease shipments. These should be timed in conformity with the necessity for regular distribution in this country. The subcommittee made the following recommendations:

1. All fertilizer operators should be notified by FPA and WPB regarding the prospective supplies of raw materials for next year and the total maximum production which apparently will be necessary to correspond closely with the demand.

2. The movement of bulk run-of-pile superphosphate from acidulators to mixers should be maintained at an equal monthly volume by arrangements between the acidulating operator and his customers, by the proper allocation of nitrogen materials which will require superphosphate to move earlier into one-season plants and by the adjustment of Triple A contracts to the end that delivery dates be specified during the period of time when acidulators will have superphosphate available over and above the amount required for mixing plant contracts.

3. An early announcement to all parties concerned regarding Federal regulations of fertilizer production and distribution during the 1943–44 season which will facilitate handling of all manufacturing problems and permit a much earlier movement of mixed goods to consumers.

4. That the limited supplies of high grade superphosphates be utilized more or less as emergency shipments to supply areas where a shortage of normal superphosphate might jeopardize Food Production goals.

Potash

WPB reported on the potash supply situation. Allocations for period 2 (ten months—June to March, inclusive) are being made to each fertilizer manufacturer, with the average of his combined purchases in 1941–42 and in 1942–43 as a basis. The estimated available supplies for the period, 564,000 tons K_2O, are in excess of the basic figure but are not sufficient to meet domestic requests in full and export requirements. It was stated that, because of changes in the supply situation, AAA does not now expect to distribute potash or 0–14–14 as grants-of-aid, as was the earlier plan.

U.S.D.A. officials presented a tentative list of grades for 1943–44. The grades are substantially as recommended at the various grade conferences. The average nitrogen content is higher than that of this year's grades, and there is considerable flexibility or range as to nitrogen and potash. The use of nitrogen in mixed fertilizer for use on small grains this fall will be permitted. U.S.D.A. expects to issue the official list in the near future.

There was some discussion of the distribution program for 1943–44. Messrs. Haskell, Douglass, Derrick, Lockwood, and Shallenberger were named as a subcommittee to work with U.S.D.A. officials on the program.

QUENCHED CALCIUM SILICATE SLAG

(Continued from page 8)

from subsequent incorporations of superphosphate. It was found, also, that the fluoride content of the slag exerted no harmful effect upon either seed germination or plant growth.

A particular concern was whether forage crops grown on slagged soils would acquire a fluorine content harmful in livestock feeding. The several forage crops grown on slagged soils in the greenhouse showed no increase in their fluorine content, even when the slag was incorporated at rates more than ten times the upper rate recommended for limestone on most soils (19).

Greenhouse Experiments

Agronomists consider that crop response under field conditions is the final measure of the nutrient value of a new fertilizer. Dependable pilot information and guidance for field trials can be obtained quickly, however, by greenhouse cultures under ideal conditions. Since the substantial output of the new type of slag is a relatively recent development, no long-time fieldplot comparisons between it and limestone have been published. The plant responses obtained in the green house experiments were solely from the slag obtained from Wilson Dam. The results from those experiments were most striking and

prompted the use of the slag on farms close to the several electric-furnace operations. Because of the favorable results obtained by farmers in those localities, the use of the slag has increased to substantial proportions and has spread rapidly to more remote sections.

The greenhouse experiments reported were integrated with several laboratory studies to determine the reactivity of the quenched slag outside and within soils, as well as the behavior and functions of its several components. Answers were sought to the question whether the slag carrying fluorides should be mixed with superphosphate outside the soil and whether the slag might decrease the value of superphosphate after the two materials are incorporated with soils (15, 17, 18, 19). Comparisons were made of the speed with which the slag, mineral calcium silicate, and limestone neutralize acidic soils. The rapidity with which the silicate content of the slag is converted to calcium carbonate outside the soil and after incorporation was also studied. Both coarse and finely ground slag were incorporated in the rate-range of 2 to 40 tons per acre to ascertain whether any harmful effect would be induced initially by heavy additions of finely ground slag. Ten successive crops, staggered legumes and nonlegumes, were grown to show whether the initially beneficial effects of a single heavy incorporation of unground slag, and repeated incorporations of it at ordinary rates, would be followed in time by an induced toxicity. The fertilizing value of the phosphate content of the slag was established by comparisons between slag alone and limestone plus superphosphate. The response to superphosphate on soils previously limestoned also was compared with the response from similar incorporations of superphosphate on previously slagged soils. The effect of the calcium fluoride content of the slag upon germination and upon the fluorine content of crops also was studied.

CONCLUSION

The results obtained through these and other related studies, supplemented by the quoted observations by ten county agents, seem to warrant certain conclusions as guide to practice.

The quenched slag is superior to an equivalent quantity of limestone of similar mechanical make-up at liming rates established as rational through field experiments and in practice.

The incorporated slag neutralizes soil acidity with equal or greater rapidity than does an equivalent incorporation of limestone.

The slag undergoes decomposition readily and then brings a quicker response by plant growth.

The sifted fines from the unground slag are more rapidly effective than the unground material.

To expedite the decomposition of the unground slag and its effective reaction within the soil, and to assure response by the initial crop, the slag should be incorporated at least a month before seeding, and preferably longer.

Equal or better response can be expected from a rational incorporation of slag alone than from a like incorporation of limestone supplemented with superphosphate to supply the same amount of phosphate as that supplied by the slag.

An incorporation of the slag at the rate of 2½ tons per acre serves as well as one of high-grade limestone at the rate of 2 tons with a 400- to 500-pound supplement of ordinary superphosphate on soils adequately neutralized by such limings.

The beneficial effects of the phosphate introduced by a 2½-ton incorporation of slag extend through the second crop and even beyond.

The unground slag can be used to advantage on soils of the types used in these experiments at rates between 2 and 4 tons, and even to 5 tons for strongly acidic soils, with a lapse of a month or more before seeding, as governed by seasonal conditions.

The response from slag, at any admissible rate, and a supplement of superphosphate can be expected to exceed the response from a corresponding incorporation of limestone and superphosphate.

Although the slag contains only a relatively small percentage of phosphate, that content is melted uniformly throughout calcium silicate, which is the chief component of the slag. Hence, when soil-incorporated slag undergoes decomposition, its phosphate con-

tent is dispersed in such a state of subdivision as to render it readily utilizable by plants.

The interval between the first and second slaggings should be the same as that found advisable in the similar use of limestone to induce and maintain a suitable soil reaction.

The harmful effect that ordinary limestone has been shown to exert upon the availability of native stores of boron in soils of some regions was not observed when the unground slag was used in the pot cultures, even at rates far beyond those at which ground limestone may repress plant growth.

The quenched slag can be distributed at any season and without the objectionable dust met in the use of finely ground limestone.

The slag furnishes practically no magnesium and therefore does not serve as a substitute for dolomite on soils.

The repressive effect that limestone may exert upon the solubility of potassium in some soils is to be anticipated also when the slag is used in lieu of limestone without potash on non-legumes.

Rational incorporations of slag exert no harmful effect upon germination or growth.

The slag induces no increase in the fluorine content of forage crops.

Prior incorporations of slag have not shown a repression upon the fertilizing value of subsequent incorporations of superphosphate.

Precautions

Because of its calcium fluoride content, the slag should not be mixed with superphosphate *outside* the soil, unless the resultant mixture is incorporated immediately.

Since it contains the fluorine compound that causes raw rock phosphate to be injurious to animals, the slag should not be used to supply calcium and phosphorus in feeds.

Farm animals should be kept away from piled slag, as they are from nitrate of soda.

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BUYERS' GUIDE • A CLASSIFIED INDEX TO ALL THE ADVERTISERS IN "THE AMERICAN FERTILIZER"

This list contains representative concerns in the Commercial Fertilizer Industry, Including fertilizer manufacturers, machinery and equipment manufacturers, dealers in and manufacturers of commercial fertilizer materials and supplies, brokers, chemists, etc.
For Alphabetical List of Advertisers, see page 33.

ACID BRICK
Charlotte Chem. Laboratories, Inc., Charlotte, N. C.
Chemical Construction Corp., New York City.

ACID EGGS
Chemical Construction Corp., New York City.

ACIDULATING UNITS
Chemical Construction Corp., New York City.
Sackett & Sons Co., The A. J., Baltimore, Md.

AMMO-PHOS
American Cyanamid Co., New York City.

AMMONIA—Anhydrous
Barrett Division, The, Allied Chemical & Dye Corp., New York City.
DuPont de Nemours & Co., E. I., Wilmington, Del.
Hydrocarbon Products Co., New York City.

AMMONIA LIQUOR
Barrett Division, The, Allied Chemical & Dye Corp., New York City.
DuPont de Nemours & Co., E. I., Wilmington, Del.
Hydrocarbon Products Co., New York City.

AMMONIA OXIDATION UNITS
Chemical Construction Corp., New York City.

AMMONIATING EQUIPMENT
Sackett & Sons Co., The A. J., Baltimore, Md.

AMMONIUM NITRATE SOLUTIONS
Barrett Division, The, Allied Chemical & Dye Corp., New York City.

AUTOMATIC ELEVATOR TAKEUPS
Sackett & Sons Co., The A. J., Baltimore, Md.

BABBITT
Sackett & Sons Co., The A. J., Baltimore, Md.

BAGS AND BAGGING—Manufacturers
Bagpak, Inc., New York City.
Bemis Bro. Bag Co., St. Louis, Mo.
St. Regis Paper Co., New York City.
Textile Bag Mfrs. Association, Chicago, Ill.
Union Bag & Paper Corporation, New York City.

BAGS—Cotton
Bemis Bro. Bag Co., St. Louis, Mo.
Textile Bag Mfrs. Association, Chicago, Ill.

BAGS—Paper
Bagpak, Inc., New York City
Bemis Bro. Bag Co., St. Louis, Mo.
St. Regis Paper Co., New York City.
Union Bag & Paper Corporation, New York City.

BAGS (Waterproof)—Manufacturers
Bemis Bro. Bag Co., St. Louis, Mo.
St. Regis Paper Co., New York City.
Textile Bag Mfrs. Association, Chicago, Ill.
Union Bag & Paper Corporation, New York City.

BAGS—Dealers and Brokers
Ashcraft-Wilkinson Co., Atlanta, Ga.
Baker & Bro., H. J., New York City.
Huber & Company, New York City.
Jett, Joseph C., Norfolk, Va.
McIver & Son, Alex. M., Charleston, S. C.
Wellmann, William E., Baltimore, Md.

BAG CLOSING MACHINES
Bagpak Inc., New York City.

BAGGING MACHINES—For Filling Sacks
Atlanta Utility Works, East Point, Ga.
Bagpak, Inc., New York City.
Sackett & Sons Co., The A. J., Baltimore, Md.

BAG PILERS
Link-Belt Company, Philadelphia, Chicago.

BEARINGS
Link-Belt Company, Philadelphia, Chicago.
Sackett & Sons Co., The A. J., Baltimore, Md.

BELT LACING
Sackett & Sons Co., The A. J., Baltimore, Md.

BELTING—Chain
Atlanta Utility Works, East Point, Ga.
Link-Belt Company, Philadelphia, Chicago.
Sackett & Sons Co., The A. J., Baltimore, Md.
Stedman's Foundry and Mach. Works, Aurora, Ind.

BELTING—Leather, Rubber, Canvas
Sackett & Sons Co., The A. J., Baltimore, Md.

BOILERS—Steam
Atlanta Utility Works, East Point, Ga.

BONE BLACK
American Agricultural Chemical Co., New York City.
Armour Fertilizer Works, Atlanta, Ga.
Huber & Company, New York City.

BONE PRODUCTS
American Agricultural Chemical Co., New York City.
Armour Fertilizer Works, Atlanta, Ga.
Ashcraft-Wilkinson Co., Atlanta, Ga.
Baker & Bro., H. J., New York City.
Bradley & Baker, New York City.
Huber & Company, New York City.
Jett, Joseph C., Norfolk, Va.
McIver & Son, Alex. M., Charleston, S. C.
Schmaltz, Jos. H., Chicago, Ill.
Wellmann, William E., Baltimore, Md.

BORAX AND BORIC ACID
American Potash and Chem. Corp., New York City.
Pacific Coast Borax Co., New York City.

BROKERS
Ashcraft-Wilkinson Co., Atlanta, Ga.
Baker & Bro., H. J., New York City.
Bradley & Baker, New York City.
Dickerson Co., The, Philadelphia, Pa.
Huber & Company, New York City.
Jett, Joseph C., Norfolk, Va.
Keim, Samuel L., Philadelphia, Pa.
McIver & Son, Alex. M., Charleston, S. C.
Schmaltz, Jos. H., Chicago, Ill.
Wellmann, William E., Baltimore, Md.

BUCKETS—Elevator
Link-Belt Company, Philadelphia, Chicago
Sackett & Sons Co., The A. J., Baltimore, Md.
Stedman's Foundry and Mach. Works, Aurora, Ind.

A Classified Index to Advertisers in "The American Fertilizer"

BUYERS' GUIDE

For an Alphabetical List of all the Advertisers, see page 33

BUCKETS—For Hoists, Cranes, etc., Clam Shell, Orange Peel, Drag Line, Special; Electrically Operated and Multi Power
Hayward Company, The, New York City.
Link-Belt Company, Philadelphia, Chicago.

BURNERS—Sulphur
Chemical Construction Corp., New York City.

BURNERS—Oil
Monarch Mfg. Works, Inc., Philadelphia, Pa.
Sackett & Sons Co., The A. J., Baltimore, Md.

CABLEWAYS
Hayward Company, The, New York City.

CARBONATE OF AMMONIA
American Agricultural Chemical Co., New York City.
DuPont de Nemours & Co., E. I., Wilmington, Del.

CARS—For Moving Materials
Link-Belt Company, Philadelphia, Chicago.
Sackett & Sons Co., The A. J., Baltimore, Md.
Stedman's Foundry and Mach. Works, Aurora, Ind.

CARTS—Fertilizer, Standard and Roller Bearing
Atlanta Utility Works, East Point, Ga.
Sackett & Sons Co., The A. J., Baltimore, Md.

CASTINGS—Acid Resisting
Charlotte Chem. Laboratories, Inc., Charlotte, N. C.
Duriron Co., Inc., The, Dayton, Ohio.

CASTINGS—Iron and Steel
Link-Belt Company, Philadelphia, Chicago.
Sackett & Sons Co., The A. J., Baltimore, Md.
Stedman's Foundry and Mach. Works, Aurora, Ind.

CEMENT—Acid-Proof
Charlotte Chem. Laboratories, Inc., Charlotte, N. C.
Chemical Construction Corp., New York City.

CHAIN DRIVES—Silent
Link-Belt Company, Philadelphia, Chicago.
Sackett & Sons Co., The A. J., Baltimore, Md.
Stedman's Foundry and Mach. Works, Aurora, Ind.

CHAINS AND SPROCKETS
Link-Belt Company, Philadelphia, Chicago.
Sackett & Sons Co., The A. J., Baltimore, Md.
Stedman's Foundry and Mach. Works, Aurora, Ind.

CHAMBERS—Acid
Chemical Construction Corp., New York City.
Fairlie, Andrew M., Atlanta, Ga.

CHEMICAL APPARATUS
Charlotte Chem. Laboratories, Inc., Charlotte, N. C.
Duriron Co., Inc., The, Dayton, Ohio.
Monarch Mfg. Works, Inc., Philadelphia, Pa.

CHEMICALS
American Agricultural Chemical Co., New York City.
American Cyanamid Co., New York City.
Armour Fertilizer Works, Atlanta, Ga.
Ashcraft-Wilkinson Co., Atlanta, Ga.
Baker & Bro., H. J., New York City.
Barrett Division, The, Allied Chemical & Dye Corp., New York City.
Bradley & Baker, New York City.
DuPont de Nemours & Co., E. I., Wilmington, Del.
Huber & Company, New York City.

CHEMICALS—Continued
International Minerals & Chemical Corporation, Chicago, Ill
McIver & Son, Alex. M., Charleston, S. C.
Phosphate Mining Co., The, New York City.
Wellmann, William E., Baltimore, Md.

CHEMICAL PLANT CONSTRUCTION
Atlanta Utility Works, East Point, Ga.
Charlotte Chem. Laboratories, Inc., Charlotte, N. C.
Chemical Construction Corp., New York City.
Fairlie, Andrew M., Atlanta, Ga.
Sackett & Sons Co., The A. J., Baltimore, Md.
Stedman's Foundry and Mach. Works, Aurora, Ind.

CHEMISTS AND ASSAYERS
Gascoyne & Co., Baltimore, Md.
Shuey & Company, Inc., Savannah, Ga.
Stillwell & Gladding, New York City.
Wiley & Company, Baltimore, Md.

CLUTCHES
Link-Belt Company, Philadelphia, Chicago.
Sackett & Sons Co., The A. J., Baltimore, Md.
Stedman's Foundry and Mach. Works, Aurora, Ind.

CONCENTRATORS—Sulphuric Acid
Chemical Construction Corp., New York City.
Fairlie, Andrew M., Atlanta, Ga.

CONDITIONERS AND FILLERS
American Limestone Co., Knoxville, Tenn.
Dickerson Co., The, Philadelphia, Pa.
Phosphate Mining Co., The, New York City.

CONTACT ACID PLANTS
Chemical Construction Corp., New York City.

COPPER SULPHATE
Tennessee Corporation, Atlanta, Ga.

COTTONSEED PRODUCTS
Ashcraft-Wilkinson Co., Atlanta, Ga.
Baker & Bro., H. J., New York City.
Bradley & Baker, New York City.
Huber & Company, New York City
Jett, Joseph C., Norfolk, Va.
McIver & Son, Alex. M., Charleston, S. C.
Schmaltz, Jos. H., Chicago, Ill.
Wellmann, William E., Baltimore, Md.

CRANES AND DERRICKS
Hayward Company, The, New York City.
Link-Belt Company, Philadelphia, Chicago.
Sackett & Sons Co., The A. J., Baltimore, Md.

CYANAMID
American Agricultural Chemical Co., New York City
American Cyanamid Co., New York City.
Ashcraft-Wilkinson Co., Atlanta, Ga.
Baker & Bro., H. J., New York City.
Bradley & Baker, New York City.
Jett, Joseph C., Norfolk, Va.
Wellmann, William E., Baltimore, Md.

DENS—Superphosphate
Chemical Construction Corp., New York City.
Stedman's Foundry and Mach. Works, Aurora, Ind.

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DISINTEGRATORS
Atlanta Utility Works, East Point, Ga.
Sackett & Sons Co., The A. J., Baltimore, Md.
Stedman's Foundry and Mach. Works, Aurora, Ind.

DRYERS—Direct Heat
Sackett & Sons Co., The A. J., Baltimore, Md.

DRIVES—Electric
Link-Belt Company, Philadelphia, Chicago.

DUMP CARS
Link-Belt Company, Philadelphia, Chicago.
Sackett & Sons Co., The A. J., Baltimore, Md.
Stedman's Foundry and Mach. Works, Aurora, Ind.

DUST COLLECTING SYSTEMS
Sackett & Sons Co., The A. J., Baltimore, Md.

ELECTRIC MOTORS AND APPLIANCES
Atlanta Utility Works, East Point, Ga.
Sackett & Sons Co., The A. J., Baltimore, Md.

ELEVATORS
Atlanta Utility Works, East Point, Ga.
Link-Belt Company, Philadelphia, Chicago.
Sackett & Sons Co., The A. J., Baltimore, Md.
Stedman's Foundry and Mach. Works, Aurora, Ind.

ELEVATORS AND CONVEYORS—Portable
Link-Belt Company, Philadelphia, Chicago.
Sackett & Sons Co., The A. J., Baltimore, Md.

ENGINEERS—Chemical and Industrial
Chemical Construction Corp., New York City.
Fairlie, Andrew M., Atlanta, Ga.
Link-Belt Company, Philadelphia, Chicago.
Sackett & Sons Co., The A. J., Baltimore, Md.
Stedman's Foundry and Mach. Works, Aurora, Ind.

ENGINES—Steam
Atlanta Utility Works, East Point, Ga.
Sackett & Sons Co., The A. J., Baltimore, Md.

EXCAVATORS AND DREDGES—Drag Line and Cableway
Hayward Company, The, New York City.
Link-Belt Company, Philadelphia, Chicago.
Link Belt Speeder Corp., Chicago, Ill., and Cedar Rapids, Iowa.

FERTILIZER MANUFACTURERS
American Agricultural Chemical Co., New York City.
American Cyanamid Company, New York City.
Armour Fertilizer Works, Atlanta, Ga.
Farmers Fertilizer Company, Columbus, Ohio.
International Minerals and Chemical Corporation, Chicago, Ill.
Phosphate Mining Co., The, New York City.
U. S. Phosphoric Products Division, Tennessee Corp., Tampa, Fla.

FISH SCRAP AND OIL
Ashcraft-Wilkinson Co., Atlanta, Ga.
Baker & Bro., H. J., New York City.
Bradley & Baker, New York City.
Huber & Company, New York City.
Jett, Joseph C., Norfolk, Va.
McIver & Son, Alex. M., Charleston, S. C.
Wellmann, William E., Baltimore, Md.

FOUNDERS AND MACHINISTS
Atlanta Utility Works, East Point, Ga.
Charlotte Chem. Laboratories, Inc., Charlotte, N. C.
Link-Belt Company, Philadelphia, Chicago.
Sackett & Sons Co., The A. J., Baltimore, Md.
Stedman's Foundry and Mach. Works, Aurora, Ind.

GARBAGE TANKAGE
Wellmann, William E., Baltimore, Md.

GEARS—Machine Moulded and Cut
Link-Belt Company, Philadelphia, Chicago.
Sackett & Sons Co., The A. J., Baltimore, Md.
Stedman's Foundry and Mach. Works, Aurora, Ind.

GEARS—Silent
Link-Belt Company, Philadelphia; Chicago.
Sackett & Sons Co., The A. J., Baltimore, Md.

GELATINE AND GLUE
American Agricultural Chemical Co., New York City.

GUANO
Baker & Bro., H. J., New York City.

HOISTS—Electric, Floor and Cage Operated, Portable
Hayward Company, The, New York City.

HOPPERS
Atlanta Utility Works, East Point, Ga.
Link-Belt Company, Philadelphia, Chicago.
Sackett & Sons Co., The A. J., Baltimore, Md.
Stedman's Foundry and Mach. Works, Aurora, Ind.

IMPORTERS, EXPORTERS
Armour Fertilizer Works, Atlanta, Ga.
Ashcraft-Wilkinson Co., Atlanta, Ga.
Baker & Bro., H. J., New York City.
Bradley & Baker, New York City.
Wellmann, William E., Baltimore, Md.

IRON SULPHATE
Tennessee Corporation, Atlanta, Ga.

INSECTICIDES
American Agricultural Chemical Co., New York City.

LACING—Belt
Sackett & Sons Co., The A. J., Baltimore, Md.

LIMESTONE
American Agricultural Chemical Co., New York City.
American Limestone Co., Knoxville, Tenn.
Ashcraft-Wilkinson Co., Atlanta, Ga.
Baker & Bro., H. J., New York City.
Bradley & Baker, New York City.
McIver & Son, Alex. M., Charleston, S. C.
Wellmann, William E., Baltimore, Md.

LOADERS—Car and Wagon, for Fertilizers
Link-Belt Company, Philadelphia, Chicago.
Sackett & Sons Co., The A. J., Baltimore, Md.

MACHINERY—Acid Making
Atlanta Utility Works, East Point, Ga.
Charlotte Chem. Laboratories, Inc., Charlotte, N. C.
Chemical Construction Corp., New York City.
Duriron Co., Inc., The, Dayton, Ohio.
Fairlie, Andrew M., Atlanta, Ga.
Monarch Mfg. Works, Inc., Philadelphia, Pa.
Sackett & Sons Co., The A. J., Baltimore, Md.
Stedman's Foundry and Mach. Works, Aurora, Ind.

MACHINERY—Coal and Ash Handling
Hayward Company, The, New York City.
Link-Belt Company, Philadelphia, Chicago.
Sackett & Sons Co., The A. J., Baltimore, Md.

MACHINERY—Elevating and Conveying
Atlanta Utility Works, East Point, Ga.
Hayward Company, The, New York City.
Link-Belt Company, Philadelphia, Chicago.
Sackett & Sons Co., The A. J., Baltimore, Md.
Stedman's Foundry and Mach. Works, Aurora, Ind.

MACHINERY—Grinding and Pulverizing
Atlanta Utility Works, East Point, Ga.
Sackett & Sons Co., The A. J., Baltimore, Md.
Stedman's Foundry and Mach. Works, Aurora, Ind.

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MACHINERY—Power Transmission
Link-Belt Company, Philadelphia, Chicago.
Sackett & Sons Co., The A. J., Baltimore, Md.
Stedman's Foundry and Mach. Works, Aurora, Ind.

MACHINERY—Pumping
Atlanta Utility Works, East Point, Ga.
Duriron Co., Inc., The, Dayton, Ohio.

MACHINERY—Tankage and Fish Scrap
Atlanta Utility Works, East Point, Ga.
Sackett & Sons Co., The A. J., Baltimore, Md.
Stedman's Foundry and Mach. Works, Aurora, Ind.

MAGNETS
Atlanta Utility Works, East Point, Ga.
Sackett & Sons Co., The A. J., Baltimore, Md.
Stedman's Foundry and Mach. Works, Aurora, Ind.

MANGANESE SULPHATE
McIver & Son, Alex. M., Charleston, S. C.
Tennessee Corporation, Atlanta, Ga.

MIXERS
Atlanta Utility Works, East Point, Ga.
Sackett & Sons Co., The A. J., Baltimore, Md.
Stedman's Foundry and Mach. Works, Aurora, Ind.

NITRATE OF SODA
American Agricultural Chemical Co., New York City.
Armour Fertilizer Works, Atlanta, Ga.
Ashcraft-Wilkinson Co., Atlanta, Ga.
Baker & Bro., H. J., New York City.
Barrett Division, The, Allied Chemical & Dye Corp., New York City.
Bradley & Baker, New York City.
Chilean Nitrate Sales Corp., New York City.
Huber & Company, New York City.
International Minerals & Chemical Corporation, Chicago, Ill.
McIver & Son, Alex. M., Charleston, S. C.
Schmaltz, Jos. H., Chicago, Ill.
Wellmann, William E., Baltimore, Md.

NITRATE OVENS AND APPARATUS
Chemical Construction Corp., New York City.

NITROGEN SOLUTIONS
Barrett Division, The, Allied Chemical & Dye Corp., New York City.

NITROGENOUS ORGANIC MATERIAL
American Agricultural Chemical Co., New York City.
Armour Fertilizer Works, Atlanta, Ga.
Ashcraft-Wilkinson Co., Atlanta, Ga.
Baker & Bro., H. J., New York City.
Bradley & Baker, New York City.
DuPont de Nemours & Co., Wilmington, Del.
Huber & Company, New York City.
International Minerals & Chemical Corporation, Chicago, Ill.
McIver & Son, Alex. M., Charleston, S. C.
Smith-Rowland Co., Norfolk, Va.
Wellmann, William E., Baltimore, Md.

NOZZLES—Spray
Monarch Mfg. Works, Philadelphia, Pa.

PACKING—For Acid Towers
Charlotte Chem. Laboratories, Inc., Charlotte, N. C.
Chemical Construction Corp., New York City.

PANS AND POTS
Stedman's Foundry and Mach. Works, Aurora, Ind.

PHOSPHATE MINING PLANTS
Chemical Construction Corp., New York City.

PHOSPHATE ROCK
American Agricultural Chemical Co., New York City.
American Cyanamid Co., New York City
Armour Fertilizer Works, Atlanta, Ga.
Ashcraft-Wilkinson Co., Atlanta, Ga.
Baker & Bro., H. J., New York City.
Bradley & Baker, New York City.
Huber & Company, New York City.
International Minerals & Chemical Corporation, Chicago, Ill.
Jett, Joseph C., Norfolk, Va.
McIver & Son, Alex. M., Charleston, S. C.
Phosphate Mining Co., The, New York City.
Ruhm, H. D., Mount Pleasant, Tenn.
Schmaltz, Jos. H., Chicago, Ill.
Southern Phosphate Corp., Baltimore, Md.
Virginia-Carolina Chemical Corp. (Mining Dept.), Richmond, Va.
Wellmann, William E., Baltimore, Md.

PIPE—Acid Resisting
Duriron Co., Inc., The, Dayton, Ohio.

PIPES—Chemical Stoneware
Chemical Construction Corp., New York City.

PIPES—Wooden
Stedman's Foundry and Mach. Works, Aurora, Ind.

PLANT CONSTRUCTION—Fertilizer and Acid
Chemical Construction Corp., New York City.
Fairlie, Andrew M., Atlanta, Ga.
Sackett & Sons Co., The A. J., Baltimore, Md.

POTASH SALTS—Dealers and Brokers
American Agricultural Chemical Co., New York City.
Armour Fertilizer Works, Atlanta, Ga.
Ashcraft-Wilkinson Co., Atlanta, Ga.
Baker & Bro., H. J., New York City.
Bradley & Baker, New York City.
Huber & Company, New York City.
International Minerals & Chemical Corporation, Chicago, Ill
Jett, Joseph C., Norfolk, Va.
Schmaltz, Jos. H., Chicago, Ill.
Wellmann, William E., Baltimore, Md.

POTASH SALTS—Manufacturers
American Potash and Chem. Corp., New York City.
Potash Co. of America, New York City.
International Minerals & Chemical Corp., Chicago, Ill.
United States Potash Co., New York City.

PULLEYS AND HANGERS
Atlanta Utility Works, East Point, Ga.
Sackett & Sons Co., The A. J., Baltimore, Md.
Stedman's Foundry and Mach. Works, Aurora, Ind.

PUMPS—Acid-Resisting
Charlotte Chem. Laboratories, Inc., Charlotte, N. C.
Duriron Co., Inc., The, Dayton, Ohio.
Monarch Mfg. Works, Inc., Philadelphia, Pa.

PYRITES—Brokers
Ashcraft-Wilkinson Co., Atlanta, Ga.
Baker & Bro., New York City.
Wellmann, William E., Baltimore, Md.

QUARTZ
Charlotte Chem. Laboratories, Inc., Charlotte, N. C

RINGS—Sulphuric Acid Tower
Chemical Construction Corp., New York City.

ROUGH AMMONIATES
Bradley & Baker, New York City.
McIver & Son, Alex. M., Charleston, S. C.
Schmaltz, Jos. H., Chicago, Ill.
Wellmann, William E., Baltimore, Md.

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SCALES—Including Automatic Bagging
Atlanta Utility Works, East Point, Ga.
Sackett & Sons Co., The A. J., Baltimore, Md.
Stedman's Foundry and Mach. Works, Aurora, Ind.

SCRAPERS—Drag
Hayward Company, The, New York City.

SCREENS
Atlanta Utility Works, East Point, Ga.
Link-Belt Company, Philadelphia, Chicago.
Sackett & Sons Co., The A. J., Baltimore, Md.
Stedman's Foundry and Mach. Works, Aurora, Ind.

SEPARATORS—Air
Sackett & Sons Co., The A. J., Baltimore, Md.

SEPARATORS—Including Vibrating
Sackett & Sons Co., The A. J., Baltimore, Md.

SEPARATORS—Magnetic
Sackett & Sons Co., The A. J., Baltimore, Md.
Stedman's Foundry and Mach. Works, Aurora, Ind.

SHAFTING
Atlanta Utility Works, East Point, Ga.
Link-Belt Company, Philadelphia, Chicago.
Sackett & Sons Co., The A. J., Baltimore, Md.
Stedman's Foundry and Mach. Works, Aurora, Ind.

SHOVELS—Power
Link-Belt Company, Philadelphia, Chicago.
Link-Belt Speeder Corporation, Chicago, Ill., and Cedar Rapids, Iowa.
Sackett & Sons Co., The A. J., Baltimore, Md.

SPRAYS—Acid Chambers
Monarch Mfg. Works, Inc., Philadelphia, Pa.

SPROCKET WHEELS (See Chains and Sprockets)

STACKS
Sackett & Sons Co., The A. J., Baltimore, Md.

SULPHATE OF AMMONIA
American Agricultural Chemical Co., New York City.
Armour Fertilizer Works, Atlanta, Ga.
Ashcraft-Wilkinson Co., Atlanta, Ga.
Baker & Bro., H. J., New York City.
Barrett Division, The, Allied Chemical & Dye Corp., New York City.
Bradley & Baker, New York City.
Huber & Company, New York City.
Hydrocarbon Products Co., New York City.
Jett, Joseph C., Norfolk, Va.
McIver & Son, Alex. M., Charleston, S. C.
Schmaltz, Jos. H., Chicago, Ill.
Wellmann, William E., Baltimore, Md.

SULPHUR
Ashcraft-Wilkinson Co., Atlanta, Ga.
Baker & Bro., H. J., New York City.
Freeport Sulphur Co., New York City.
Texas Gulf Sulphur Co., New York City.

SULPHURIC ACID
American Agricultural Chemical Co., New York City.
Armour Fertilizer Works, Atlanta, Ga.
Ashcraft-Wilkinson Co., Atlanta, Ga.
Baker & Bro., H. J., New York City.
Bradley & Baker, New York City.
Huber & Company, New York City.
International Minerals & Chemical Corporation, Chicago, Ill.
Jett, Joseph C., Norfolk, Va.
McIver & Son, Alex. M. Charleston, S. C.

SULPHURIC ACID—Continued
U. S. Phosphoric Products Division, Tennessee Corp., Tampa, Fla.
Wellmann, William E., Baltimore, Md.

SUPERPHOSPHATE
American Agricultural Chemical Co., New York City.
Armour Fertilizer Works, Atlanta, Ga.
Ashcraft-Wilkinson Co., Atlanta, Ga.
Baker & Bro., H. J., New York City.
Bradley & Baker, New York City.
Huber & Company, New York City.
International Minerals & Chemical Corporation, Chicago, Ill.
Jett, Joseph C., Norfolk, Va.
McIver & Son, Alex. M., Charleston, S. C.
Schmaltz, Jos. H., Chicago, Ill.
U. S. Phosphoric Products Division, Tennessee Corp., Tampa, Fla.
Wellmann, William E., Baltimore, Md.

SUPERPHOSPHATE—Concentrated
Armour Fertilizer Works, Atlanta, Ga.
International Minerals & Chemical Corporation, Chicago, Ill
Phosphate Mining Co., The, New York City.
U. S. Phosphoric Products Division, Tennessee Corp., Tampa, Fla.

SYPHONS—For Acid
Monarch Mfg. Works, Inc., Philadelphia, Pa.

TALLOW AND GREASE
American Agricultural Chemical Co., New York City.

TANKAGE
American Agricultural Chemical Co., New York City.
Armour Fertilizer Works, Atlanta, Ga.
Ashcraft-Wilkinson Co., Atlanta, Ga.
Baker & Bro., H. J., New York City.
Bradley & Baker, New York City.
International Minerals & Chemical Corporation, Chicago, Ill.
Jett, Joseph C., Norfolk, Va.
McIver & Son, Alex. M., Charleston, S. C.
Schmaltz, Jos. H., Chicago, Ill.
Smith-Rowland, Norfolk, Va.
Wellmann, William E., Baltimore, Md.

TANKAGE—Garbage
Huber & Company, New York City.

TANKS
Sackett & Sons, Co., The A. J., Baltimore, Md.

TILE—Acid-Proof
Charlotte Chem. Laboratories, Inc., Charlotte, N. C.

TOWERS—Acid and Absorption
Chemical Construction Corp., New York City.
Fairlie, Andrew M., Atlanta, Ga.

UNLOADERS—Car and Boat
Hayward Company, The, New York City.
Sackett & Sons Co., The A. J., Baltimore, Md.

UREA
DuPont de Nemours & Co., E. I., Wilmington, Del.

UREA-AMMONIA LIQUOR
DuPont de Nemours & Co., E. I., Wilmington, Del.

VALVES—Acid-Resisting
Atlanta Utility Works, East Point, Ga.
Charlotte Chem. Laboratories, Inc., Charlotte, N. C.
Duriron Co., Inc., The, Dayton, Ohio.
Monarch Mfg. Works, Inc., Philadelphia, Pa.

WHEELBARROW (See Carts)

ZINC SULPHATE
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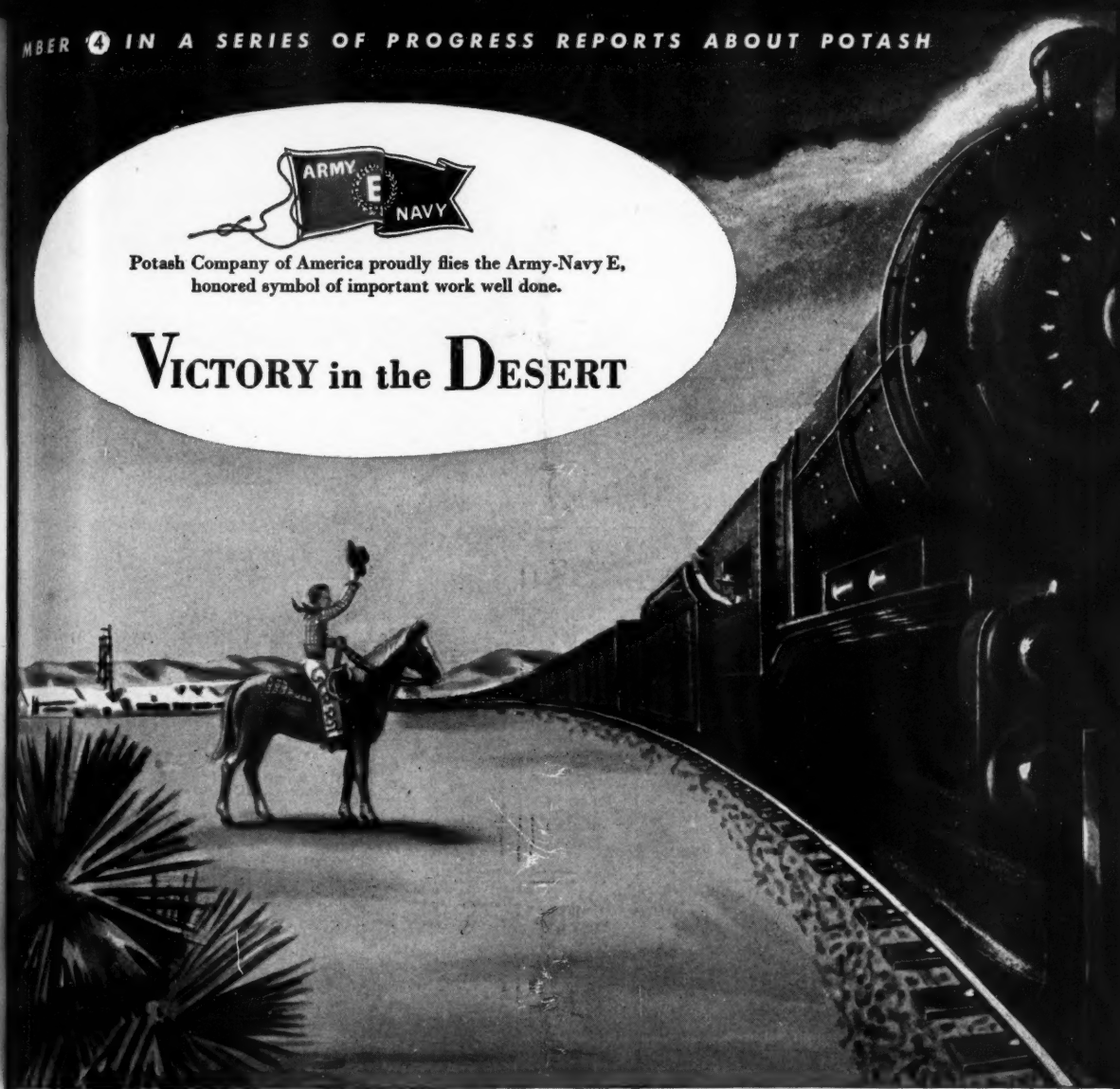

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